770-A

HICKOK

INSTRUCTION MANUAL

for

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MODEL 770 A

CATHODE RAY OSCILLOSCOPE

Manual No. 2490-497

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The Hickok Electrical Instrument Company warrants instruments of its manufacture to be free from defects in material and workmanship for ninety (90) days from the date of original purchase. Any instrument found to be defective during this period may be returned, transportation prepaid, to the factory for repair, or at our option, replaced without charge.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither shall the warranty apply where a warranty registration card has not been properly completed and returned to us promptly after purchase. This warranty is in lieu of all other warranties whether expressed or implied.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, the factory must first be contacted, giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly either to the Hickok factory address at 10626 Leuer Avenue, Cleveland, Ohio, 44108, or to a designated service station in your locality.

SECTION 1

GENERAL INFORMATION

DESCRIPTION

The Model 770A Oscilloscope is a rugged, accurate test instrument, especially designed to meet the needs of the industrial user and the professional technician. With the Model 770A, any three dynamic parameters which can be expressed as voltages may be displayed as an intensity-modulated trace. Two axes (Y and Z) may be referenced to an internally generated time-base.

Some of the Model 770A's design features are as follows: 5 inch flat face CRT; eighteen calibrated sweep rates, accurate to within ± 3%, from 0.5 sec/cm to 1 μsec/cm (with 5X expansion to 0.2 μsec/cm); a calibrated vertical amplifier with a sensitivity of .01 volt/cm to 50 volts/cm; trigger controlled sweeps; and 4 mc response to provide true pulse reproduction.

QUICK REFERENCE DATA

a. POWER REQUIREMENTS - 105 to 125 or 210 to 250 volts, 50 to 400 cps, 130 watts.

b. VERTICAL DEFLECTION SYSTEM -

Sensitivity: DC Coupled - 0.1 to 50 volts/cm in six steps, continuously variable between steps, -extendible to 500 volts/cm with X10 probe.

Sensitivity: AC Coupled - .01 to .05 volt/cm in two steps, continuously variable between steps.

Accuracy - overall accuracy - 3% with probe attached.

Frequency Response - AC only - ± 3 db, 3 cps to 4 mc, .1 v/cm range or higher ± 3 db, 3 cps to 3.5 mc, .01 v/cm range, ac coupled.
DC - ± 3 db to 4 mc.

Maximum Input Voltage - 6000 volts peak-to-peak.

Input Impedance: Direct - 1 megohm shunted by 45 picofarads - with X10 probe, 10 megohms shunted by 15 picofarads, or less.

c. HORIZONTAL DEFLECTION SYSTEM -

Sweep Generator - eighteen calibrated sweep rates (accurate to within - 3%) from 0.5 second/cm to 1 microsecond/cm. Continuously variable uncalibrated adjustment between ranges extends slowest sweep rate to approximately 1.5 seconds/cm.

Magnifier - X5 magnifier expands scale by five times and effectively increases the sweep speed to 0.2 usec/cm.

Trigger Input Requirements - internal trigger (one-half cm vertical signal), line trigger (internally supplied), external trigger (0.2 volts p-p).

Horizontal Amplifier - basic sensitivity, 1.0 volt/cm; frequency response, 3 cps to 500 kcps, step attenuator X1 and X10; variable attenuator, 10 to 1; maximum input voltage, 400 volts peak-to-peak.

d. CATHODE RAY TUBE - 5ADP31(A) with an accelleration potential of 3500 volts.

e. CALIBRATOR - 1/2 volt peak-to-peak at line frequency, square wave with rise time of approximately 75 microseconds, and with a voltage accuracy of ± 3%.

SECTION 2

OPERATING INSTRUCTIONS

GENERAL

The Model 770A Oscilloscope is a versatile instrument, which may be used in a large number of applications. The user will find it to his advantage to become thoroughly familiar with the controls of this particular unit.

The Model 770A is cooled by convection. For this reason, it is important that the unit be operated in a location where there is adequate air circulation.

If this instrument is connected to the proper power source (as indicated on the nameplate) and if no other connections are made to the instrument, it is impossible to damage the instrument with any settings of the panel controls.

> WARNING
>
> Care should be taken when operating this instrument with the case removed as high and dangerous voltages are present. All care and necessary precautions should be observed when handling the cathode-ray tube because of the danger of implosion.

FRONT PANEL CONTROLS AND CONNECTORS

The purpose and function of the front panel controls and connectors (See figure 1) are as follows:

a. CRT CONTROLS

FOCUS - Varies the voltage on the focus grid of the CRT.

INTENSITY - Adjusts the bias between the control grid and the cathode of the CRT. Rotation in a clockwise direction increases the intensity of the trace.

ASTIG - Adjusts the voltage on the second anode. This control is used in conjunction with the FOCUS control to obtain a sharp, clearly defined trace without astigmatism.

VERTICAL POSITION - Thumb wheel to position the trace vertically on the face of the scope.

HORIZONTAL POSITION - Thumb wheel to position the trace horizontally on the face of the scope.

b. VERTICAL AMPLIFIER CONTROLS

VOLT/CM - Eight position switch to select various compensated attenuators in vertical amplifier and to insert or remove the preamplifier. -- VARIABLE (in red on panel refers to red knob mounted concentrically with VOLT/CM switch), provides continuous attenuation between calibrated sensitivities.

INPUT MODE - Three position switch to connect or remove a capacitor for ac or dc operation and to connect the input grid of the amplifier to ground for setting the reference level.

GAIN ADJ - Variable screwdriver control to recalibrate the vertical amplifier by varying the gain.

DC BAL - Variable screwdriver control to balance the dc amplifier to prevent shift in the vertical trace when the vertical input sensitivity is changed.

c. TIME BASE CONTROLS

TIME/CM - Eighteen position rotary switch to select fixed timing resistors and capacitors to provide eighteen sweep rates between 0.5 sec/cm and 1 μsec/cm. -- VARIABLE (in red on panel refers to red knob mounted concentrically with TIME/CM switch), provides continuously variable sweep speed, between the calibrated sweep rates.

HORIZONTAL DISPLAY - Five position rotary switch provides calibrated magnification of the sweep X1 or X5, provides horizontal amplification X1 or X10; and provides phaseable line frequency sweep of 10 cm.

AMP GAIN - Provides variable length of line sweep, also provides variable gain for horizontal amplifier (operates in conjunction with HORIZONTAL DISPLAY switch when in AMP X1 and X10 positions.)

PHASING - Provides approximately 180° phasing control for line sweep.

TRIGGER SLOPE - Six position rotary switch - determines slope of the triggering waveform to which the time base circuit is synchronized.

TRIGGER LEVEL - Selects one of two modes of sweep operation; auto, or driven and determines level on the triggering waveform to which the time base sweep is locked.

STABILITY - Variable control to adjust the sweep-gating multivibrator to its most sensitive mode of operation.

d. FRONT PANEL CONNECTORS

INPUT - UHF type connector to vertical input.

CAL OUT - Binding post, supplies 0.5 volt

peak-to-peak, 60 cycle square wave output for calibration purposes.

TRIGGER INPUT - Binding post to provide for external trigger input.

GND - Binding posts (2) to provide direct connection to chassis of the instrument.

Z AXIS - Binding post to provide for Z axis input and/or external blanking.

AMP INPUT - Binding post to provide for horizontal amplifier input.

e. REAR PANEL CONNECTIONS (See Figure 2).

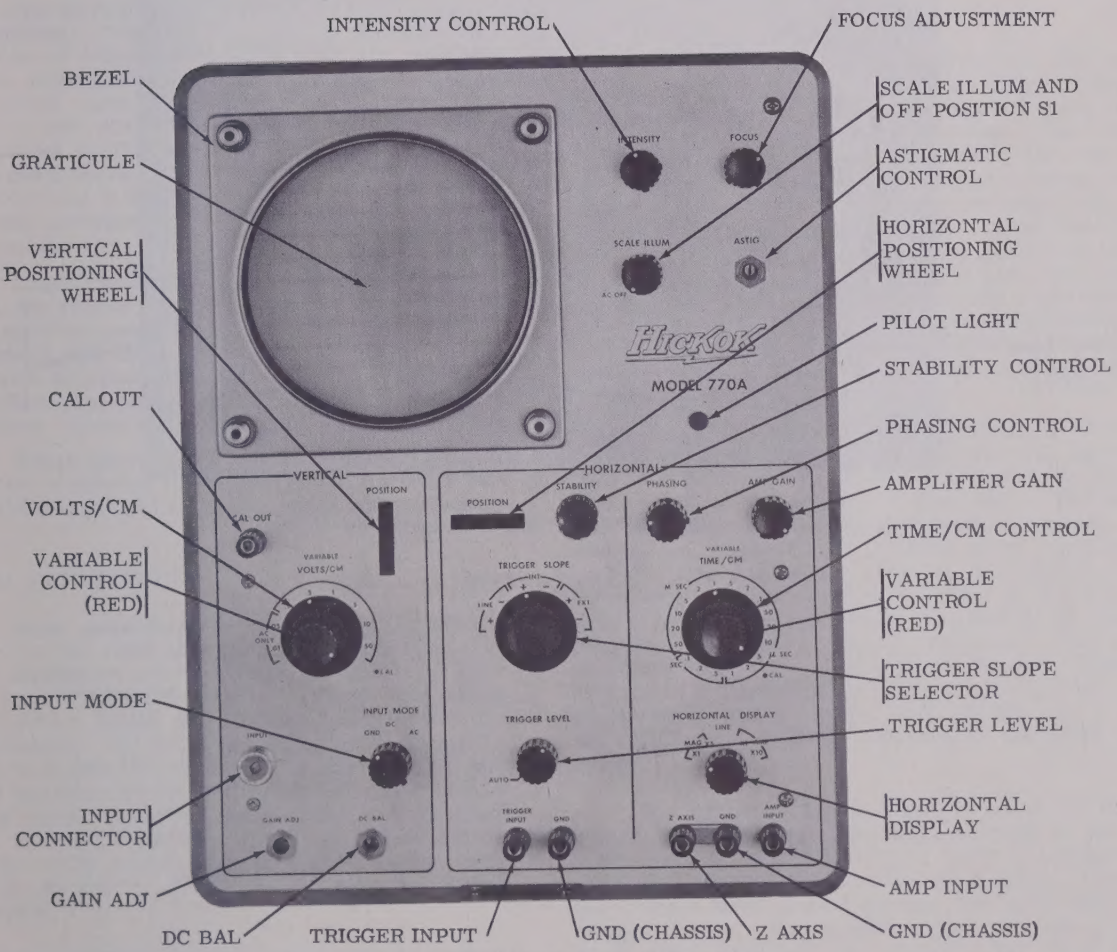


Fig. 1 Front Panel Controls and Connectors

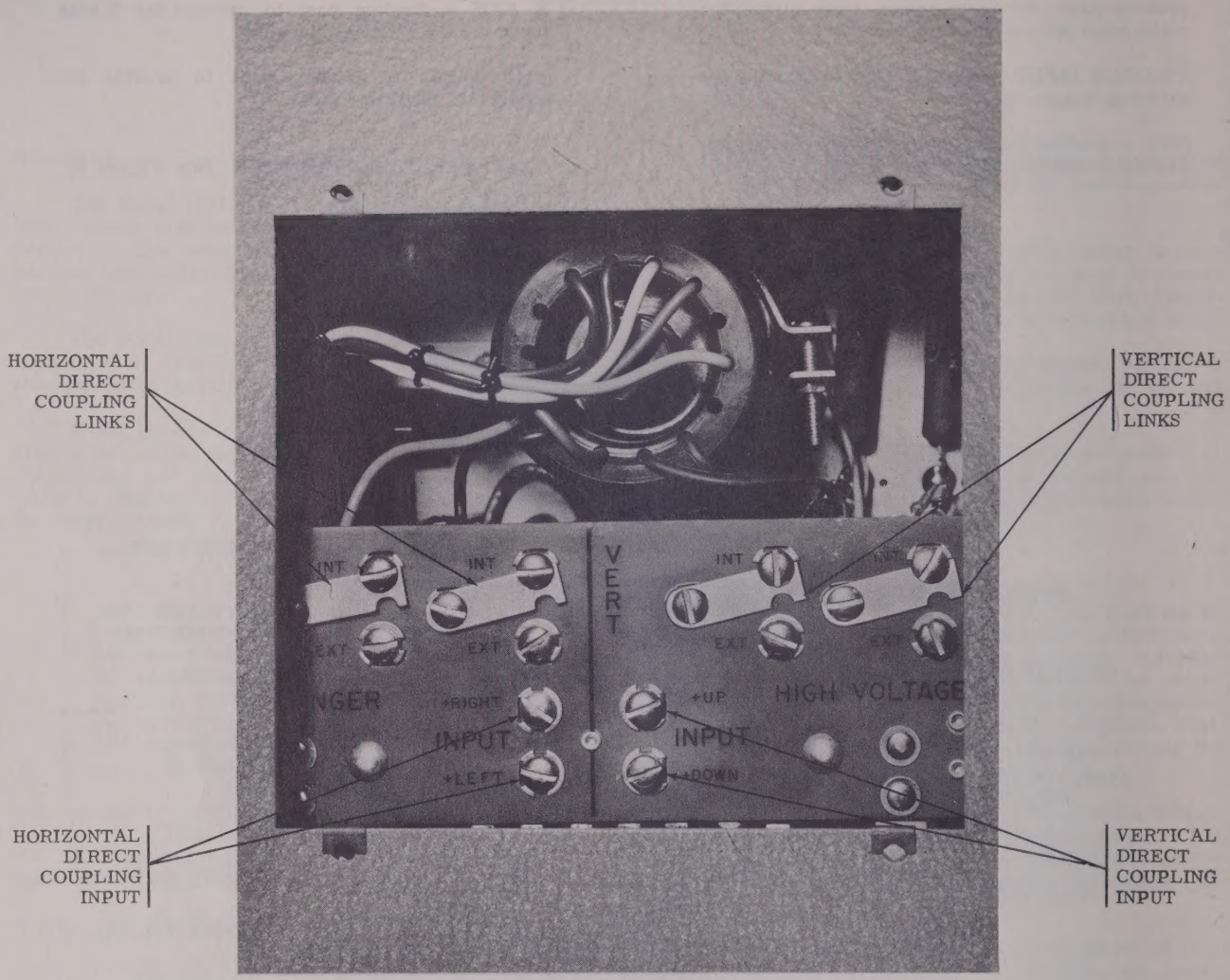


Fig. 2 Rear Panel Connections

SECTION 3

CIRCUIT DESCRIPTION

INTRODUCTION

In the interest of simplicity, the circuit description is divided into functional units which are described and discussed separately. The block diagram (figure 3) and the schematic wiring diagram (in the back of this manual) are both referred to for identification.

GENERAL

The block diagram permits an explanation of the signal flow and the interrelationship of the various circuits, except for the power supply and attenuators. The switching shown does not represent the actual connection, but rather the function of the switching.

The input wave forms are connected to the vertical input connector. The INPUT MODE switch permits the selection of either AC or DC coupling of the amplifier. The preamplifier provides a gain of 10 in front of the vertical amplifier on the two most sensitive positions of the VOLT/CM switch. The preamplifier is switched out and becomes a cathode follower for the other six positions of the VOLT/CM switch. The vertical amplifier has a basic calibrated sensitivity of 0.1 volt/cm and provides push-pull output to the vertical deflection plates.

The trigger pick-off circuit applies a sample of the input wave-form to the trigger amplifier. The trigger amplifier amplifies the triggering wave-form and couples it into the trigger shaper and differentiation circuits to produce a sharp trigger pulse. This pulse is then applied to the input of the sweep-gating multivibrator, which turns on the sweep generator.

The sweep generator produces a linear voltage ramp which is coupled to the horizontal amplifier input, amplified and applied to the horizontal deflection plates.

VERTICAL DEFLECTION

The input wave-form is connected to the INPUT connector for the vertical amplifier. Frequency-compensated attenuators are switched into the input circuit by the VOLTS/CM switch. Three attenuators are used either singly or in tandem pairs to provide eight calibrated VOLT/CM sensitivities. The AC-coupled preamplifier is switched into the input circuit on the ac positions of the VOLT/CM switch to provide a total of eight calibrated sensitivities. A blocking capacitor is coupled into the circuit and is independent of the VOLT/CM switch when on the AC ONLY position. It is coupled in all other positions by the INPUT MODE switch.

The preamplifier consists of the pentode section of V1A used as a single ended amplifier. The gain of this stage is set by R13 which varies the Gm of the stage by changing the plate current.

The vertical amplifier consists of the preamplifier pentode connected as a triode input follower, two stages of gain, and an intermediate driver-follower stage. The first stage of gain is provided by the pentode section of V2A which is cathode coupled to the input follower and operates as a grounded grid single ended amplifier. The output of this stage is applied to V2B, the active intermediate follower which drives the final vertical amplifier. The final vertical amplifier provides a push-pull output which is applied to the vertical deflector plates. Positioning is achieved by changing the grid bias on the inactive side of the final vertical amplifier through the inactive intermediate follower V1B. The internal trigger pick-off is taken from the cathode of the active intermediate follower V2B and ac-coupled to the input of the trigger amplifier.

HORIZONTAL DEFLECTION

The TRIGGER SLOPE switch selects the trigger source and arranges the input of the trigger amplifier to produce either a positive or negative going wave-form for a positive input wave-form. The trigger amplifier is a differential amplifier. The output is always taken from the pentode section. Slope reversal is achieved by switching the input signal from the triode grid to the pentode grid. Since the trigger shaper requires a negative going signal to change states, the positive sloped sync signals are applied to the triode grid. The opposite grid is attached to a dc bias source, adjustable by the TRIGGER LEVEL control. Changing the TRIGGER LEVEL control changes the dc output level of the pentode plate and thus the input grid bias of the trigger shaper.

The trigger shaper is essentially a bi-stable Schmitt trigger. In the quiescent state the input pentode is conducting and the output triode is cut off. The triode grid is dc coupled to the plate of the pentode and the cathodes are coupled through a common cathode return resistor. A negative going signal at the pentode grid causes the plate to go positive, which carries the grid of the triode section up into the plate conduction region and raises the cathode so that the pentode conduction is further reduced. This action continued until the sections have changed states and the triode is conducting and the pentode is cut off. This regenerative action occurs very quickly and a steep negative going step is produced at the plate of the triode.

The amplitude of the signal at which the trigger shaper switches states, and thus the point on the input wave-form at which the trigger pulse is produced, is dependent upon the bias of the input stage. Adjusting the trigger level control changes the input bias of the trigger shaper. For smaller signals the bias must be made more negative, i.e., closer to the cutoff region of the shaper, in order to trip the trigger shaper.

In the AUTO position of the TRIGGER LEVEL control the trigger shaper is connected as a free-running or as an astable multivibrator. Triggering is accom-

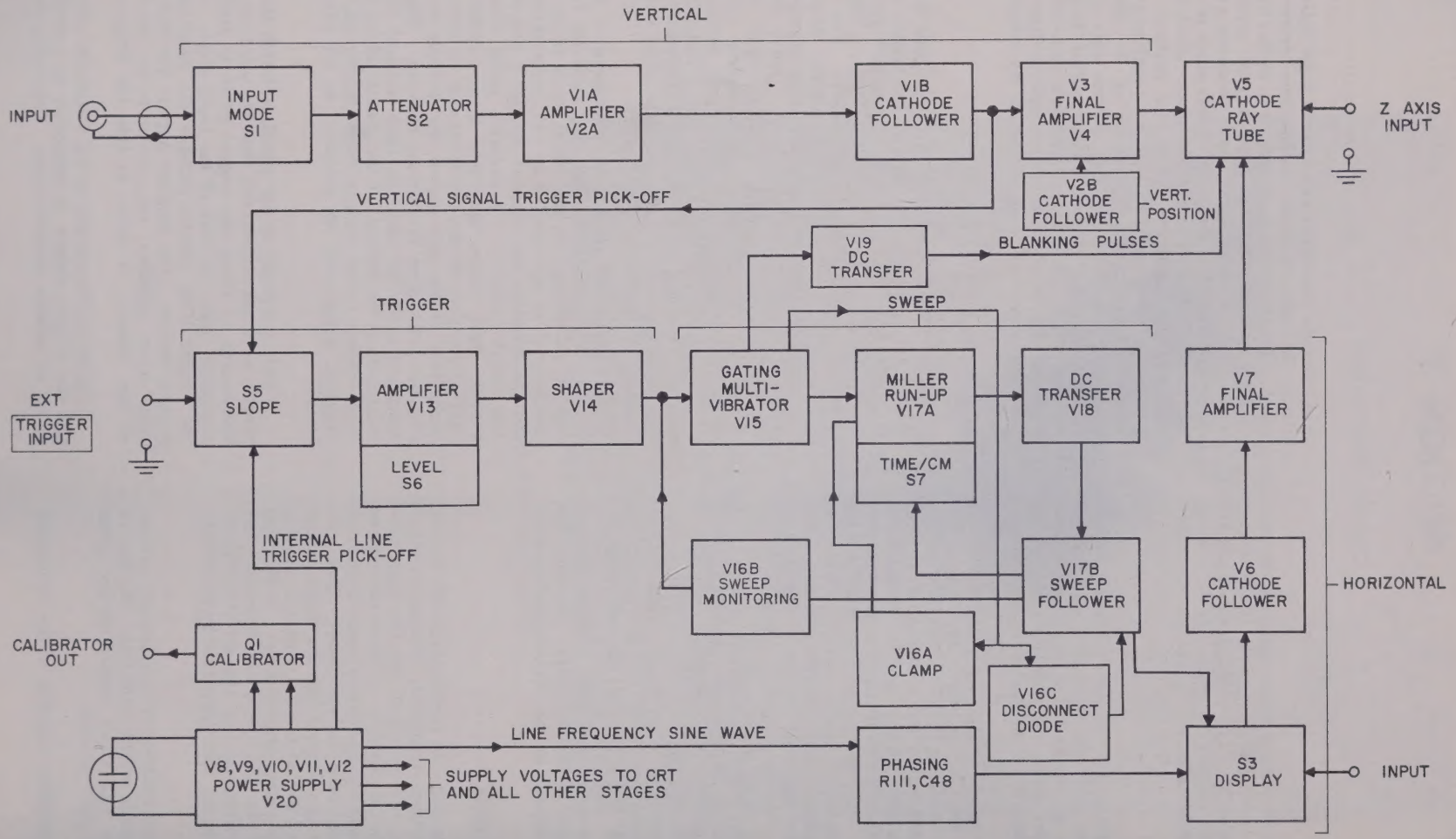


Fig. 3 Functional Block Diagram

plished by adding the amplified input wave-form to the dc input grid bias, which causes the trigger shaper to fire. The negative going step output of the trigger shaper is applied to a differentiation circuit which produces a sharp negative pulse. This pulse is coupled into the input grid of the sweep-gating multivibrator. The sweep-gating multivibrator turns the sweep on when the negative trigger pulse is applied to the input grid and is prevented from switching again until the sweep is completed by the hold off network between the pentode plate and the triode grid. The sweep-gating multivibrator consists of V15 connected as a Schmitt trigger. In its latent state, the triode input section is conducting and the pentode output is at cutoff. A negative trigger pulse causes the multivibrator to switch states as described for the trigger shaper. To return the multivibrator to its original state a positive signal is required at the input grid.

The STABILITY control adjusts the input grid bias voltage of the sweep-gating multivibrator near the point where it will switch states for maximum sensitivity to the negative trigger pulse. The sweep monitoring diode is normally cutoff and therefore does not contribute to the bias voltage.

The sweep generator is a Miller-Integrator circuit and consists of V16A the clamping triode, V16C the disconnect diode, V17 the Miller tube and follower, and V16B the sweep monitoring diode. Between sweeps the clamping cathode of the Miller run-up tube and the plate coupled follower output at + 103 volts.

A sharp negative pulse applied to the input grid of the sweep gating multivibrator, causes the multivibration to switch states. The sharp negative step that is produced at the plate of the output triode causes the clamping triode to release the grid of the Miller run-up tube and the diode to release the cathode of the plate coupled follower. The Miller tube and the plate coupled cathode follower then seek their own voltage levels. The grid of the Miller starts negative and the plate positive, carrying the cathode follower positive also. This raises the voltage at the top end of the charging capacitor coupling the Miller tube grid to the follower cathode. Also it tends to prevent the grid from going negative. Since the gain of the Miller tube is very high, the plate signal feedback to the grid through the charging capacitor keeps the grid voltage very nearly constant. At the same time the charging capacitor is charging with the current flowing through the grid timing resistor. Since the grid voltage of the Miller tube remains constant within a small fraction of a volt, the current flowing through the grid resistor will be essentially constant and the charging capacitor changes at a constant rate. Thus a linear voltage ramp is produced. If any change from a linear rise occurs in the cathode follower, it will result in a change in the grid voltage in the direction that will produce a change in the plate voltage of the proper amount to compensate for the deviation.

As the cathode of the plate coupled cathode follower rises, a fixed portion of the positive going voltage ramp is coupled to the input grid of the sweepgating multivibrator through the length control (R168) and the sweep monitoring diode. When the feedback portion of the ramp reaches the input bias level of the multivibrator, the monitoring diode connects and pulls the bias divide up with the linear voltage ramp. When the voltage at the input grid reaches the point where the triode (V15A) is in the plate conduction region, the multivibrator switches states. The steep positive going step at the plate of the pentode connects the clamping triode to the grid of the Miller tube and discharges the timing capacitor. As the Miller tube grid returns to its clamped point the plate drops carrying the cathode follower with it. The cathode of the cathode follower falls until the disconnect diode stops it around the + 103 volt regulation point. Varying the amount of ramp voltage feedback, by adjusting the length control, sets the length of the sweep.

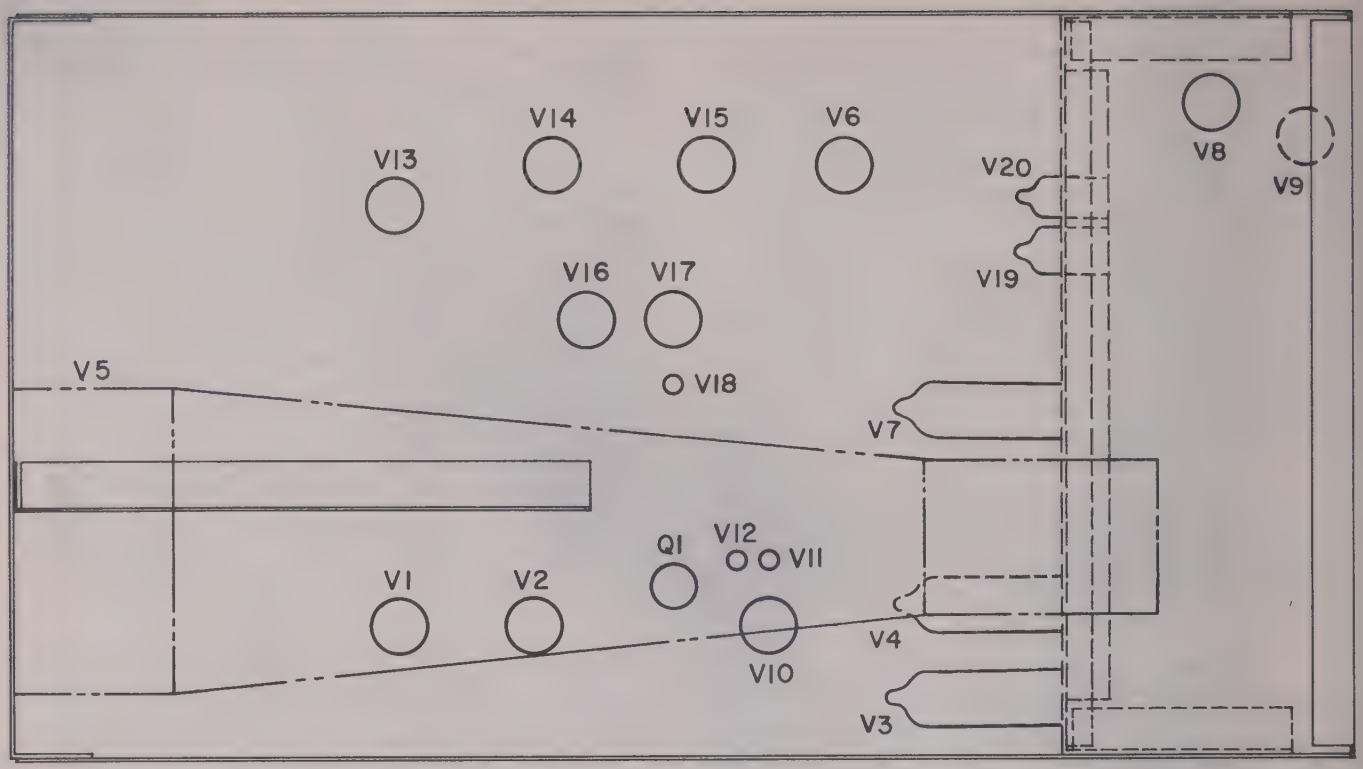
The sweep output passes through an attenuation network and is dc coupled into the horizontal amplifier. The horizontal amplifier is a cathode-coupled phase splitter amplifier that provides a push-pull output. The output of the horizontal amplifier is used to drive the horizontal deflection plates.

In the MAG X5 position of the HORIZONTAL DISPLAY switch the attenuation of the sweep is decreased, resulting in an expansion of the horizontal sweep by five times. In the LINE position of the Horizontal Display the sweep generator is disconnected and a variable phase line frequency signal is connected to the normally inactive grid of the horizontal amplifier.

In the AMP positions of the HORIZONTAL DISPLAY control, the signal to be displayed is connected to the AMP INPUT binding post. In the X1 position the signal is not attenuated but in the X10 position a ten times attenuator is switched into the circuit. Control of the horizontal gain in the LINE and AMP positions of the HORIZONTAL DISPLAY control is provided by the AMP GAIN. In these positions the AMP GAIN changes the coupling between the cathodes of the horizontal amplifier and therefore the gain. The attenuation provided by this control is continuous up to ten times.

BLANKING

The blanking pulse is supplied by the plate of the input stage of the sweep gating multivibrator and is dc coupled to the grid of the CRT through V19.



BOTTOM VIEW

Fig. 4 Tube Locations

SYMBOL DESIG.	TUBE TYPE	FUNCTION
V1	6GH8A	Vertical Preamp, Main Amplifier
V2	6KR8A	and Followers
V3, V4	12GN7A	Vertical Finals
V5	5ADP31(A)	Cathode Ray Tube
V6, V7	6BQ7A	Horizontal Follower and Final
V8, V9	1X2B	High Voltage Rectifiers
V10	6G11	+103V Regulator
V11, V12	NE-2	Regulators for V10A Plate Supply
V13, V14	6GH8A	Trigger Amplifier -- Inverter and Schmitt Trigger
V15	6U8A	Bi-Stable Multivibrator
V16	6BV8	Clamp Follower, Disconnect and Sweep-Monitoring Diodes
V17	6GH8A	Miller Run-Up and Follower
V18	NE-2	DC Transfer
V19, V20	GV3A-1500	High Voltage Regulator and DC Blanking Transfer

SECTION 4

MAINTENANCE AND CALIBRATION

MAINTENANCE

The Oscilloscope Model 770A is made by skilled workmen with quality components and should require little or no maintenance other than routine tube replacement. It is suggested that if the instrument should need service or maintenance, the factory service department or one of our authorized service stations be contacted for service or advice. For tube locations, see Fig. 4.

CALIBRATION

The Model 770A has been carefully calibrated at the factory. It should require no maintenance over a long period of trouble-free service. If, however, due to mechanical, or electrical damage, or component replacement, recalibration is necessary, proceed as follows:

PRELIMINARY

Connect the oscilloscope to a proper power source. See Quick Reference Data on page 1. Turn the SCALE ILLUM to the ON position. Allow 5 minutes warm-up time. Set the controls and switches as indicated in Table 1.

The INTENSITY control, the FOCUS adjustment, and the ASTIG control have some degree of interdependency which will necessitate readjusting or "trimming" these controls.

Adjust the SCALE ILLUM for individual preference.

Set the PHASING control and the AMP GAIN control to their maximum counter clockwise positions.

Alterations in the basic test setup as outlined above, are noted in each paragraph of these calibration procedures, otherwise the controls and switches shall be replaced as indicated.

PRECALIBRATION VOLTAGE SUPPLY CHECK

Connect a VTVM between the + 103 volt buss and the -47 volt buss. Adjust R23C (+ 150 volt supply adjust) for an output voltage of + 150 volts. The -47 volt buss to ground should read between -44.6 and -49.4 volts. The + 203 volt buss to ground should read between + 180 and + 221 volts. The + 353 volt buss to ground should read between + 313 and + 393 volts.

To check the high voltage supply, connect the VTVM between the -1500 volt buss and ground. Meter should read between -1450 and -1550 volts.

PRECALIBRATION CRT CHECK

Adjust the HORIZONTAL and the VERTICAL POSITION controls and the INTENSITY control to obtain a trace on the face of the screen. Adjust the ASTIG control, the INTENSITY control, and the FOCUS adjustment for a clearly defined trace of normal intensity.

Align the trace with one of the horizontal graticule lines with the VERTICAL POSITION control. If any tilt in the trace is present, release the base of the CRT and rotate the CRT until it is aligned with the horizontal graticule line.

CALIBRATION PROCEDURE

Calibrator Output. Connect a VTVM to the CAL OUT binding post and adjust R23B (cal amplitude set)

FRONT PANEL CONTROLS	POSITION
INTENSITY	"Normal" intensity trace
FOCUS	Focused trace
ASTIG	For best focus consistent with any position of the trace
SCALE ILLUM	Individual preference
TRIGGER SLOPE	+ INT
TRIGGER LEVEL	FREE RUN
HORIZONTAL DISPLAY	MAG X1
TIME/CM	1 M SEC
VARIABLE TIME/CM (RED)	CAL
HORIZONTAL POSITION	Centered trace
VERTICAL POSITION	Centered trace
INPUT MODE	DC
VOLT/CM	.1
VARIABLE VOLT/CM (RED)	CAL
STABILITY	MAX CW

Table 1. Control and Switch Settings for Calibration

for a plus 0.25 V dc output (0.5 volt peak-to-peak square wave).

Vertical Amplifier DC Balance. Adjust the DC BAL control so that the trace remains stationary as the VARIABLE VOLT/CM (red knob) control is rotated back and forth throughout its range. Return the VARIABLE VOLT/CM (red knob) control to the CAL position.

Vertical Gain. Set the INPUT MODE to DC and the front-panel GAIN ADJ to Max. Connect a 0.5V dc calibrated signal to the vertical INPUT. Obtain a stable display, using the TRIGGER LEVEL and STABILITY controls. Adjust the GAIN CAL control R40 for a 5cm display, then set the front-panel GAIN ADJ for a 4.3cm display. Re-adjust R40 for a 5cm display.

Preamp Gain. Set the VOLTS/CM switch to 0.01. Connect a 0.05V ac calibrated signal to the vertical INPUT. Adjust R13 (preamp gain cal) for exactly 5cms of deflection. Now return the VOLTS/CM switch to .1V, and re-adjust the GAIN and BALANCE controls to maintain calibration on the .1V/CM range. Since the two ranges interact, repeat the procedure on each range until both achieve calibration.

Frequency Compensation of Input Attenuator. Set the INPUT MODE to DC. Adjust C67 for an input capacity of 47pf with the VOLTS/CM switch set at .01V. Adjust C8 for 47pf with the VOLTS/CM switch set at .1V. Connect the output of a square wave generator at 1KC to the vertical INPUT of the oscilloscope. Set the STABILITY and TRIGGER LEVEL switches for a locked display. Make adjustments for a perfect square wave by adjusting the capacitor specified in Table 2 below. NOTE: Vertical calibration will vary with the setting of the ASTIG control. All adjustments must be made with one optimum setting of this control.

VOLTS/CM SWITCH POSITION	DEFLECTION	ADJUST CAPACITOR
0.05	4cm	C11
0.5	4cm	C13
1.0	5cm	C3
50.0	2cm	C6

Table 2. Compensation of VOLTS/CM Switch Positions.

Probe and Input Standardization. Connect the 10:1 probe to the INPUT of the oscilloscope, and connect the probe across the output of a square wave generator. Use non-metallic adjustment tool to make the adjustments indicated in Table 3, with 5cm deflection.

VOLTS/CM SWITCH POSITION	ADJUST CAPACITOR
0.10	Probe Compensation Capacitor
0.05	C9
0.5	C10
1.0	C2
10.0	C5

Table 3. Probe and Input Standardization.

HORIZONTAL DEFLECTION CALIBRATION

Trigger Circuits. Set up the Model 770A as indicated in Table 1. To adjust the STABILITY control for driven mode set the TRIGGER LEVEL to its mechanical center of adjustment. Slowly rotate clockwise the STABILITY control until the free-running trace appears, then back off the STABILITY control in a counterclockwise direction until the free-running trace disappears.

Internal Trigger Functions. By means of a jumper, connect the CAL OUT binding post with the VERTICAL INPUT connector. Obtain a locked display by adjusting the TRIGGER LEVEL control and proceed as follows:

1. Switch the TRIGGER SLOPE selector to -INT and adjust R75B (trigger level centering - see schematic wiring diagram) for a stable display.

2. Return the TRIGGER SLOPE selector to +INT and adjust the TRIGGER LEVEL control to obtain a stable display.

3. Repeat steps 1 and 2 until a stable display is obtained as the TRIGGER SLOPE selector is switched from -INT to +INT and back, inverting reliably each time.

4. Repeat steps 1, 2 and 3, using the 10:1 AC PROBE.

Connect a square wave generator at 1KC to the TRIGGER INPUT jack and adjust for 2 cm deflection. Set the TRIGGER SLOPE selector to + EXT and adjust the TRIGGER LEVEL for a stable display. Switch to -EXT and again adjust the TRIGGER LEVEL for a stable display.

Switch TRIGGER LEVEL to the AUTO position with INPUT MODE in the GND position. Remove the external trigger. Set the TRIGGER SLOPE selector on the + INT position. A trace should be obtained on all TIME/CM positions.

Leave the TRIGGER LEVEL in the AUTO position. Set the INPUT MODE to the DC position. This automatically locks the signal.

Time/cm - 5 ms to 0.1 ms Ranges. To calibrate for 5 ms to 0.1 ms, perform the following:

1. Set the VOLT/CM switch to the 1 volt position.

2. Connect the output of a time mark generator (Hickok Model 1817, or equal), to the VERTICAL INPUT connector of the Model 770A.

3. Apply 1 ms marker.

4. Adjust the VARIABLE control (red) of the VOLT/CM switch for 5 cms.

5. By means of the HORIZONTAL POSITION control position the second marker under the second major graticule line. By adjusting resistors R79 (sweep gain), R75C (5ms to 0.1 ms sweep cal), and R168(sweep length), position the tenth marker under the ninth vertical graticule line. The markers from the second through the ninth graticule lines shall align with their respective graticule lines within ±1 millimeter.

Sweep Length. Adjust R168 (sweep length) for an overall sweep length of 10.5 cm.

Horizontal Magnification.

1. Turn the HORIZONTAL DISPLAY to the MAG X5 position. Center the fifth marker horizontally on the graticule by means of the HORIZONTAL POSITION control. Return the HORIZONTAL DISPLAY to the MAG X1 position. Adjust R75A (sweep mag. regis.) to restore the fifth marker to the center of the graticule.

2. Turn the HORIZONTAL DISPLAY to the MAG X5 position. The fourth and sixth markers should fall under the first and last major graticule division within ±2.5 mm. If the markers do not coincide with the end graticule lines, check the resistors across R75A.

Time/cm - 0.5 Sec/cm to 10 Mc/cm.

1. Set TIME/CM control to 0.1 sec/cm, and set TRIGGER LEVEL to adjust for a locked display.

2. Apply 0.1 second markers from a time mark generator (Hickok Model 1817, or equal). By means of the HORIZONTAL POSITION control, position the second marker under the second major graticule division. Adjust R75D (0.5 sec to 10 ms sweep cal) to align the tenth marker with the ninth major graticule division. The second through the ninth markers should align with their respective graticule lines within ± 1 millimeter.

3. Check calibration of the 0.5 sec/cm and the 10 ms/cm ranges. With the second marker under the second major graticule division, the tenth marker should align with the ninth major graticule division within 5 millimeters.

High Frequency Compensation of Sweep Divide.

1. For high frequency compensation of sweep divide, set up the controls as follows:

INTENSITY	Maximum
INPUT MODE	GND
TRIGGER LEVEL	as specified
HORIZONTAL DISPLAY	as specified
TIME/CM	as specified
TRIGGER SLOPE	+ LINE
R60 (500K blanking)	max. intensity

2. Change the TIME/CM control to 10 μSEC and the TRIGGER LEVEL to the AUTO position. By means of the HORIZONTAL POSITION control, position the left end of the trace on the screen and switch the HORIZONTAL DISPLAY to MAG X5. Adjust C64 and C65 so that no overshoot nor undershoot are apparent on the left end of trace.

3. Switch the HORIZONTAL DISPLAY back to MAG X1 and adjust C64 so that no overshoot nor undershoot is apparent on the left end of the trace.

4. Switch the HORIZONTAL DISPLAY back to MAG X5 and adjust C65 to eliminate overshoot or undershoot.

5. Repeat steps 3 and 4 as often as necessary until best compensation is achieved.

Time/cm - 50 μ SEC to 1 μ SEC Ranges.

To calibrate for 50 μ SEC to 1 μ SEC, perform the following:

1. Set the TIME/CM switch to the 10 μ SEC position.

2. Set the HORIZONTAL DISPLAY to the MAG X1 position.

3. Set the TRIGGER LEVEL between AUTO and FREE RUN to establish a locked display.

4. Apply 10 μ sec output from a time mark generator (Hickok Model 1817, or equal). By means of the HORIZONTAL POSITION control, position the second marker under the second major division. Adjust C61 (50 μ sec to 1 μ sec sweep cal) to align the tenth marker under the ninth major division.

Horizontal Input Circuit. Set the HORIZONTAL DISPLAY to AMP X10. Connect a 50 volt, 1Kc square wave to the HORIZONTAL AMP INPUT. Connect a sweep sawtooth signal to the VERTICAL INPUT. Sync the signals to obtain a display of the horizontal deflection swept in the vertical direction. Adjust C38 for best square wave.

High Frequency Compensation of Vertical Amplifier. For high frequency compensation of the vertical amplifier make the basic set up as shown in Table 1 with the exception of the TIME/CM control and the TRIGGER LEVEL. Set the TIME/CM control to the 1 μ SEC position and adjust the TRIGGER LEVEL for a locked trace.

Set the square wave generator for a 400 Kc output and connect it to the VERTICAL INPUT with appropriate termination. Adjust the output for 6cm of deflection.

Rotate C66 CW until an overshoot appears on the leading edge of the square wave, then back off C66 until the overshoot is 1mm or less. Switch the VOLTS/CM selector to .01V and re-adjust the output of the generator for six centimeters deflection. Adjust L1 in the preamp for the best square wave with an overshoot - undershoot that does not exceed 2mm of deflection.

INTRODUCTION

Reference designations are assigned to identify all parts of the Model 770A Oscilloscope. These designations are used in the parts list and schematic wiring diagram. The letter prefix of a reference designation indicates the kind of part -- resistor, capacitor, electron tube, et cetera.

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
C1		CAPACITOR, FIXED, PAPER: 10 μf, 600 V, 10%	3105-207	.63
C2		CAPACITOR, VARIABLE, CERAMIC: 5-25 pf, NPO	3115-57	1.26
C3		Same as C2		
C4		CAPACITOR, FIXED, FILM: 100 pf, 5%, 500 V, tubular	3102-101	.44
C5		Same as C2		
C6		Same as C2		
C7		CAPACITOR, FIXED, FILM: 1500 pf, 5%, 500 V, tubular	3102-152	.60
C8		CAPACITOR, VARIABLE, CERAMIC: 1.5-7 pf, NPO	3115-34	.44
C9		CAPACITOR, VARIABLE, CERAMIC: 3-12 pf, NPO	3115-58	1.03
C10		Same as C2		
C11		Same as C2		
C12		CAPACITOR, FIXED, FILM: 33 pf, 5%, 500 V, tubular	3102-330	.60
C13		Same as C8		
C14		CAPACITOR, FIXED, CERAMIC: .005 μf, 20%, 1000 V	3110-218	.60
C15		CAPACITOR, FIXED, ELECTROLYTIC: 1200 μf, 6 V	3085-208	1.40
C16		CAPACITOR, FIXED, PLASTIC: .047 μf, 200 V, tubular	3105-376	1.04
C17		Same as C14		
C18		CAPACITOR, FIXED, MYLAR: .47 μf, 200 V, tubular	3090-46	.83
C19		Same as C18		
C20		Same as C14		
C21		Same as C14		
C22A, B, C		CAPACITOR, FIXED, ELECTROLYTIC: 100-100-10 μf, 350 V	3085-220	4.71
C23		Same as C14		
C24		Same as C14		
C25		Same as C14		
C26		CAPACITOR, FIXED, ELECTROLYTIC: 20 μf, 450 V	3085-76	1.15
C27		CAPACITOR, FIXED, PAPER: .1 μf, 10%, 600V	3105-385	.70
C28		Same as C27		
		CAPACITOR, FIXED, MYLAR: .5 μf, 10%, 400 V		1.92

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
C30		CAPACITOR, FIXED, MYLAR: .047 μf, 2000 V, tubular	3090-57	1.08
C31		CAPACITOR, FIXED: .1 μf, 2000 V, Tubular	3090-56	1.08
C32		CAPACITOR, FIXED, CERAMIC: .220 pf, 3000 V	3110-262	.59
C33		Same as C27		
C34		Same as C27		
C35		Same as C18		
C36		Same as C4		
C37		CAPACITOR, FIXED, FILM: 470 pf, 5%, 500 V, tubular	3102-471	.49
C38		Same as C2		
C39		CAPACITOR, FIXED, PAPER: .022 μf, 400 volts, tubular	3105-378	1.03
C40		CAPACITOR, FIXED: .25 μf, 20%, 2500 V, tubular	3090-58	1.08
C41		Same as C40		
C42A, B, C		Same as C22		
C43		Same as C31		
C44		CAPACITOR, FIXED, ELECTROLYTIC: 500 μf, 50V	3085-303	1.89
C45		CAPACITOR, FIXED, CERAMIC: .01 μf, 150V	3110-94	.49
C46		Same as C18		
C47		CAPACITOR, FIXED, ELECTROLYTIC: 10 μf, 150V	3085-281	1.08
C48		CAPACITOR, FIXED, MYLAR: 1 μf, 20%, 200 V, tubular	3090-28	.99
C49		Same as C39		
C50		CAPACITOR, FIXED, MYLAR: .1 μf, 20%, 200 V, tubular	3090-20	.52
C51		Same as C45		
C52		Same as C45		
C53		CAPACITOR, FIXED, FILM: 27 pf, 5%, 500 V, tubular	3102-270	.60
C54		CAPACITOR, FIXED, CERAMIC: 10 pf, 10%, 600 V, tubular	3110-217	.60
C55		CAPACITOR, FIXED, FILM: 47 pf, 5%, 500 V, tubular	3102-470	.60
C56		Same as C55		
C57		CAPACITOR, FIXED, PLASTIC COATED: .5 μf, 400 V	3105-224	1.08
C58		CAPACITOR, FIXED, FILM: 5000 pf, 5%, 500 V, tubular	3102-502	.60
C59		Same as C29		
C60		Same as C58		

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
C61		Same as C2		
C62		CAPACITOR, FIXED, FILM: 39 pf, 5%, 500 V, tubular	3102-390	.60
C63		Same as C14		
C64		CAPACITOR, VARIABLE, CERAMIC: 8-50 pf,	3115-39	.99
C65		Same as C64		
C66		CAPACITOR, VARIABLE: 350-1180 pf	3115-62	1.80
C67		Same as C9		
C68		CAPACITOR, FIXED, ELECTROLYTIC: 12 μf, 450 V, tubular	3105-224	1.08
C69		CAPACITOR, FIXED, ELECTROLYTIC: 2500 μf, 6.4 V, tubular	3085-305	1.26
C70		Same as C50		
C71		CAPACITOR, FIXED, DISC CERAMIC: .1 μf, +80-20%, 25 V	3114-004	1.26
C72		Same as C71		
C73		Same as C47		
CR1		SEMI-CONDUCTOR DEVICE, DIODE: SS-4 rectifier 400 PIV, 10 amp surge	3870-129	1.62
CR2		Same as CR1		
CR3		Same as CR1		
CR4		Same as CR1		
CR5		Same as CR1		
CR6		Same as CR1		
CR7		Same as CR1		
CR8		Same as CR1		
CR9		SEMI-CONDUCTOR DEVICE, DIODE: zener 1N4756A, 1 W	3870-182	4.50
CR10		SEMI-CONDUCTOR DEVICE, DIODE: 1N198A germanium, 80 V PIV	3870-65	1.58
CR11		Same as CR1		
CR12		Same as CR10		
CR13		Same as CR1		
CR14		Same as CR1		
CR15		Same as CR1		
DS1		LAMP: pilot, clear red, with resistor	12270-60	.90
DS2		LAMP: #50 pilot, miniature screw base, 6-8 V	12270-65	.60

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO	PRICE EACH
DS3		Same as DS2		
F1		FUSE: 1-1/2 amp, SLO-BLO	6900-9	.58
J1		CONNECTOR: Teflon filled	3475-158	2.14
J2		BINDING POST: Insulated nylon, black	2360-109	1.19
J3		Same as J2		
J4		Same as J2		
J5		Same as J2		
J6		Same as J2		
J7		Same as J2		
L1		COIL: Peaking, Preamp	3320-326	.70
L2		COIL: 4.7 μh ±10%	3250-514	1.08
L3		COIL, FIXED: 10 μh ±10%, iron core	3250-518	1.08
L4		Same as L3		
Q1		TRANSISTOR: NPN, 2N1605, 150 MW	20861-51	10.15
Q2		RECTIFIER: Silicon Controlled, MCR-2305-2	18150-78	3.88
R1		RESISTOR, FIXED, FILM: 900 K ohms, 1%, 1/2 W	18537-53	.59
R2		RESISTOR, FIXED, FILM: 110 K ohms, 1%, 1/2 W	18694-489	.64
R3		RESISTOR, FIXED, FILM: 990K ohms, 1%, 1/2 W	18537-144	1.15
R4		RESISTOR, FIXED, FILM: 10.1 K ohms, 1%, 1/2 W	18537-261	.58
R5		RESISTOR, FIXED, FILM: 800 K ohms, 1%, 1/2 W	18537-264	.52
R6		RESISTOR, FIXED, FILM: 250 k ohms, 1%, 1/2 W	18537-265	1.94
R7		RESISTOR, FIXED, FILM: 1 megohm, 1%, 1/2 W	18694-581	.55
R8		RESISTOR, FIXED, COMPOSITION: 100 K ohms, 10%, 1/2 W	18414-102	.40
R9		RESISTOR, FIXED, COMPOSITION: 100 ohms, 10%, 1/2 W	18411-102	.40
R10		RESISTOR, FIXED, COMPOSITION: 120 ohms, 10%, 2 W	18431-122	.63
R11		RESISTOR, FIXED, COMPOSITION: 1500 ohms, 10%, 1/2 W	18412-152	.40
R12		RESISTOR, FIXED, COMPOSITION: 7.5 K ohms, 5%, 1 W	18422-751	.55
R13		RESISTOR, VARIABLE: composition, 5000 ohms, 10%, 1/2 W, linear taper, snap-in type	40500-502	1.40
R14		RESISTOR, VARIABLE: composition, 2500 ohms, 20%, 1/2 W, inverse log taper	16925-547	.75
R15		RESISTOR, FIXED, COMPOSITION: 1.3 megohms, 5%, 1/2 W	18415-131	.47
R16		RESISTOR, FIXED, COMPOSITION: 56 K ohms, 5%, 1/2 W	18413-561	.47

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
R17		RESISTOR, FIXED, COMPOSITION: 1.2 megohms, 5%, 1/2 W	18415-121	.47
R18		RESISTOR, FIXED, COMPOSITION: 220 ohms, 10%, 1/2 W	18411-222	.40
R19		RESISTOR, VARIABLE, COMPOSITION: 200 ohms, 20% 1/2 W, linear taper	16925-603	1.62
R20		Same as R9		
R21		RESISTOR, FIXED, COMPOSITION: 2.7K ohms, 10%, 1/2 W	18412-272	.40
R22		RESISTOR, FIXED, COMPOSITION: 10K ohms, 10%, 1 W	18423-102	.44
R23A, B, C		RESISTOR ASSY, VARIABLE: composition, 15K ohms, 20%, 2K ohms, 30%, 2K ohms, 20% tab terminals, vert. mount, low profile knob	16925-525	5.18
R24		RESISTOR, FIXED, COMPOSITION: 2.7 megohms, 5%, 1/2 W	18415-271	.44
R25		RESISTOR, VARIABLE: composition, 250K ohms, 20%, 1/2 W	16925-549	1.62
R26		RESISTOR, FIXED, COMPOSITION: 1 megohm, 5%, 1/2 W	18415-101	.44
R27		RESISTOR, VARIABLE: composition: 250K ohms, 20%, 1/2 W linear taper	16925-546	1.62
R28		RESISTOR, FIXED, COMPOSITION: 5.6 megohms, 5%, 1/2W	18415-561	.44
R29		RESISTOR, FIXED, COMPOSITION: 110K ohms, 5%, 1/2 W	18414-111	.47
R30		RESISTOR, FIXED, COMPOSITION: 47 ohms, 10%, 1/2 W	18410-472	.40
R31		Same as R30		
R32		RESISTOR, FIXED, COMPOSITION: 30K ohms, 5%, 2 W	18433-301	.68
R33		Same as R32		
R34		RESISTOR, FIXED, COMPOSITION: 5.1K ohms, 5%, 1 W	18422-511	.52
R35		RESISTOR, FIXED, COMPOSITION: 2.2K ohms, 10%, 1/2 W	18412-222	.40
R36		Same as 30		
R37		Same as 30		
R38		RESISTOR, FIXED, WIRE WOUND: 4.7K ohms, 1%, 10 W	18575-451	3.26
R39		Same as R38		
R40		RESISTOR, VARIABLE: composition, 500 ohms, 20%, 1/2 W, linear taper, snap-in type	16925-231	.59
R41		RESISTOR, FIXED, COMPOSITION: 1 megohm, 10%, 1/2 W	18415-102	.40
R42		Same as R41		
R43		RESISTOR, FIXED, WIRE WOUND: 6000 ohms, 5%, 5W	18575-475	.97
R44		Same as R43		
R45		RESISTOR, FIXED, WIRE WOUND: 1000 ohms, 5%, 5 W	18575-455	.94

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
R46		RESISTOR, FIXED, COMPOSITION: 3000 ohms, 5%, 1/2 W	18412-301	.47
R47		RESISTOR, FIXED, COMPOSITION: 6.8K ohms, 10%, 2 W	18432-682	.52
R48		RESISTOR, FIXED, COMPOSITION: 2.2 megohms, 10%, 1/2 W	18415-222	.40
R49		Same as R48		
R50		RESISTOR, FIXED, COMPOSITION: 5.6 megohms, 10%, 1/2 W	18415-562	.40
R51		Same as R50		
R52		RESISTOR, FIXED, COMPOSITION: 33K ohms, 10%, 1/2 W	18413-332	.40
R53		RESISTOR, VARIABLE: composition, 100K ohms, 10%, 1/2 W, linear taper	16925-602	1.62
R54		RESISTOR, FIXED, COMPOSITION: 120K ohms, 10%, 1/2 W	18414-122	.40
R55		Same as R48		
R56		RESISTOR, FIXED, COMPOSITION: 39K ohms, 10%, 1/2 W	18413-392	.40
R57		Same as R41		
R58		RESISTOR, FIXED, COMPOSITION: 6.2 megohms, 5%, 2 W	18435-621	.75
R59		RESISTOR, VARIABLE: composition, 500K ohms, 20%, 1/2 W linear	16925-522	4.65
R60		Same as R59		
R61		RESISTOR, FIXED, COMPOSITION: 15 ohms, 10%, 2 W	18430-152	.49
R62		RESISTOR, FIXED, COMPOSITION: 3.9 megohms, 10%, 2 W	18435-392	.52
R63		RESISTOR, VARIABLE: composition 1 megohm, 20% 1/2 W linear	16925-517	4.65
R64		RESISTOR, FIXED, COMPOSITION: 2.7 megohms, 5%, 2 W	18435-271	.75
R65		Same as R48		
R66		Same as R48		
R67		Same as R50		
R68		Same as R50		
R69		Same as R30		
R70		RESISTOR, FIXED, COMPOSITION: 240K ohms, 5%, 1/2 W	18414-241	.47
R71		RESISTOR, FIXED, COMPOSITION: 82K ohms, 10%, 1/2 W	18413-822	.40
R72		Same as R70		
R73		Same as R8		
R74		Same as R30		
R75 A, B, C, D		RESISTOR ASSY, VARIABLE: 4 section, composition, 25K ohms, 10%; 25K ohms, 30%; 250K ohms, 30%; 50K ohms, 30% tab terminals, vert. mount	16925-524	5.18

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
R76		RESISTOR, FIXED, COMPOSITION: 39K ohms, 10%, 2 W	18433-392	.52
R77		Same as R32		
R78		RESISTOR, FIXED, COMPOSITION: 2.2 megohms, 5%, 1/2 W	18415-221	.47
R79		Same as R13		
R80		RESISTOR, FIXED, COMPOSITION: 560K ohms, 5%, 1/2 W	18414-561	.47
R81		RESISTOR, FIXED, COMPOSITION: 200K ohms, 5%, 1/2 W	18414-201	.47
R82		RESISTOR, FIXED, COMPOSITION: 36K ohms, 5% 2 W	18433-361	.69
R83		Same as R32		
R84		Same as R30		
R85		RESISTOR, VARIABLE: composition, 50K ohms, 20%, 1/2 W, linear	16925-534	1.62
R86		Same as R8		
R87		Same as R30		
R88		Same as R78		
R89		RESISTOR, FIXED, COMPOSITION: 750K ohms, 5%, 2 W	18434-751	.70
R90		RESISTOR, FIXED, COMPOSITION: 10 ohms, 10%, 2 W	18430-102	.52
R91		Same as R90		
R92		RESISTOR, FIXED, COMPOSITION: 10 megohms, 10%, 2 W	18436-102	.52
R93		RESISTOR, FIXED, COMPOSITION: 180K ohms, 5%, 1/2 W	18414-181	.47
R94		Same as R56		
R95		RESISTOR, FIXED, WIRE WOUND: 2.7 ohms, 5%, 5 W	18575-474	.88
R96		RESISTOR, FIXED, COMPOSITION: 12 ohms, 10%, 1/2 W	18410-122	.40
R97		Same as R48		
R98		Same as R30		
R99		RESISTOR, FIXED, COMPOSITION: 2000 ohms, 5%, 1/2 W	18412-201	.47
R100		Same as R9		
R101		RESISTOR, FIXED, COMPOSITION: 18K ohms, 10%, 2 W	18433-182	.52
R102		RESISTOR, FIXED, WIRE WOUND: 1000 ohms, 5%, 15 W	18575-452	1.73
R103		RESISTOR, FIXED, COMPOSITION: 100K ohms, 5%, 1/2 W	18414-101	.47
R104		RESISTOR, VARIABLE: wire wound, 25 ohms, 20%, 2 W, linear taper, with AC switch mounted on rear, SPST, off in CCW rotation	16925-536	5.58
R105		Same as R41		

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
R106		RESISTOR, FIXED, COMPOSITION: 4.7K ohms, 10%, 1 W	18422-472	.44
R107		Same as R8		
R108		Same as R56		
R109		RESISTOR, FIXED, COMPOSITION: 3.3 K ohms, 10%, 1/2 W	18412-332	.40
R110		RESISTOR, FIXED, COMPOSITION: 27 K ohms, 10%, 1 W	18423-272	.44
R111		RESISTOR, VARIABLE: composition, 100 K ohms, 1/2 W, log taper	16925-249	.90
R112		RESISTOR, FIXED, COMPOSITION: 390K ohms, 10%, 1/2 W	18414-392	.40
R113		Same as R54		
R114		Same as R41		
R115		Same as R93		
R116		RESISTOR, FIXED, COMPOSITION: 390 K ohms, 5%, 1/2 W	18414-391	.47
R117		RESISTOR, FIXED, COMPOSITION: 430 K ohms, 5%, 1/2 W	18414-431	.47
R118		Same as R93		
R119		Same as R9		
R120		Same as R9		
R121		Same as R17		
R122		Part of S6		
R123		RESISTOR, FIXED, COMPOSITION: 4.7 K ohms, 10%, 1/2 W	18412-472	.40
R124		Same as R106		
R125		RESISTOR, FIXED, COMPOSITION: 330 K ohms, 5%, 1/2 W	18414-331	.47
R126		Same as R93		
R127		Same as R8		
R128		Same as R30		
R129		Same as R41		
R130		Same as R116		
R131		RESISTOR, FIXED, COMPOSITION: 120 K ohms, 5%, 1/2 W	18414-121	.42
R132		Same as R11		
R133		Same as R123		
R134		RESISTOR, FIXED, COMPOSITION: 8.2 K ohms, 10%, 1 W	18422-822	.44
R135		Same as R21		
R136		Same as R30		

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
R137		Same as R116		
R138		Same as R131		
R139		RESISTOR, FIXED, COMPOSITION: 5.6K ohms, 10%, 1/2 W	18412-562	.40
R140		RESISTOR, FIXED, COMPOSITION: 270K ohms, 5%, 1/2 W	18414-271	.47
R141		Same as R29		
R142		RESISTOR, VARIABLE: composition, 25K ohms, 20%, 1/2 W	16925-545	.79
R143		RESISTOR, FIXED, COMPOSITION: 300K ohms, 5%, 1/2 W	18414-301	.47
R144		Same as R30		
R145		RESISTOR, FIXED, COMPOSITION: 10K ohms, 10%, 1/2 W	18413-102	.40
R146		Same as R22		
R147		RESISTOR, FIXED, COMPOSITION: 1600 ohms, 10%, 1/2 W	18412-162	.40
R148		RESISTOR, FIXED, COMPOSITION: 820K ohms, 10%, 1/2 W	18414-822	.40
R149		Same as R30		
R150		RESISTOR, FIXED, COMPOSITION: 150K ohms, 5%, 1/2 W	18414-151	.47
R151		RESISTOR, FIXED, COMPOSITION: 75K ohms, 5%, 1/2 W	18413-751	.47
R152		RESISTOR, FIXED: 15 megohms, 1%, 1 W	18550-203	2.56
R153		RESISTOR, FIXED, FILM: 3 megohms, 1%, 1/2 W	18537-88	.85
R154		RESISTOR, FIXED, FILM: 600K ohms, 1%, 1/2 W	18537-85	1.12
R155		RESISTOR, FIXED, FILM: 6 megohms, 1%, 1/2 W	18537-87	1.12
R156		RESISTOR, FIXED, FILM: 1.5 megohms, 1%, 1/2 W	18694-598	.63
R157		RESISTOR, FIXED, FILM: 300K ohms, 1%, 1/2 W	18537-24	1.08
R158		Same as R30		
R159		Same as R30		
R160		RESISTOR, FIXED, COMPOSITION: 47K ohms, 5%, 2 W	18433-471	.70
R161		RESISTOR, VARIABLE: composition, 100K ohms, 20%, 1/2 W, linear taper	16925-550	3.88
R162		RESISTOR, FIXED, COMPOSITION: 100K ohms, 10%, 1 W	18424-102	..44
R163		Same as R41		
R164		RESISTOR, FIXED, COMPOSITION: 47K ohms, 10%, 1/2 W	18413-472	.40
R165		Same as R52		
R166		Same as R30		
R167		RESISTOR, FIXED, COMPOSITION: 22K ohms, 10%, 2 W	18433-222	.52

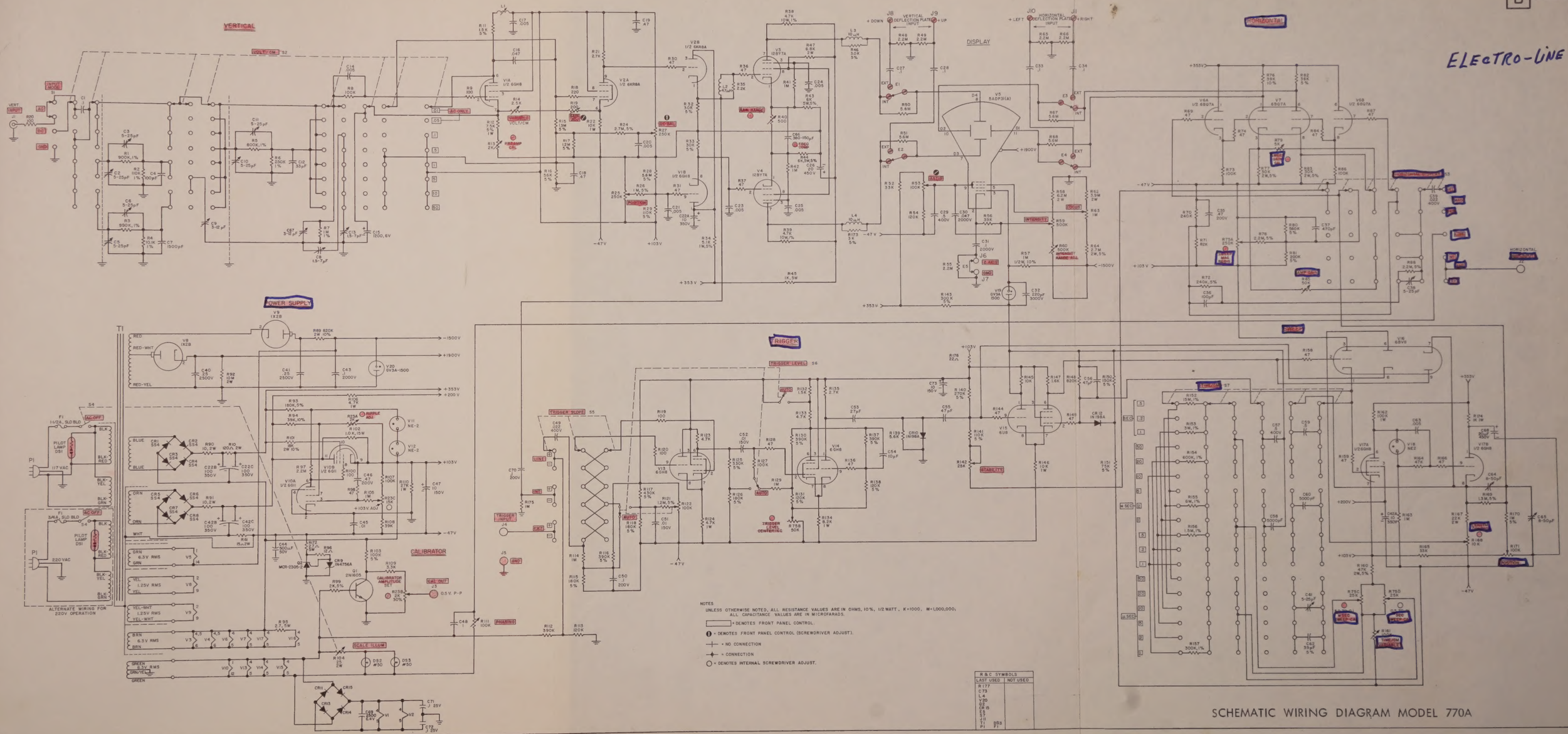
REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
R168		RESISTOR, VARIABLE; composition, 10K ohms, 20%, 2W, linear taper	40101-103	2.50
R169		Same as R15		
R170		Same as R26		
R171		RESISTOR, VARIABLE: composition, 100K ohms, 20%, 1/2 W, linear taper	16925-548	1.62
R172		Same as R95		
R173		Same as R46		
R174		RESISTOR, FIXED, COMPOSITION: 1000 ohms, 10%, 1 W	18422-102	.44
R175		Same as R41		
R176		RESISTOR, FIXED, COMPOSITION: 22 ohms, 10%, 1/2 W	18410-222	.40
S1		SWITCH, ROTARY: input mode, 1 section, 3 position	19912-576	1.08
S2		SWITCH, ROTARY: vertical sensitivity, 4 sections, 8 positions	19912-550	10.15
S3		SWITCH, ROTARY: horizontal display selector, 2 sections, 5 positions	19912-575	1.76
S4		Part of R104		
S5		SWITCH, ROTARY; trigger slope selector, 2 sections 6 positions	19912-573	7.68
S6		SWITCH, ROTARY: trigger level, 100K ohms potentiometer mounted on rear deck	19912-574	7.35
S7		SWITCH, ROTARY: sweep rate selector, 3 sections, 18 positions	19912-551	6.75
T1		TRANSFORMER: power	20800-316	24.59
V1		TUBE: 6GH8	20875-239	1.79
V2		TUBE: 6KR8A	20875-259	
V3		TUBE: 12GN7A	20875-257	2.59
V4		Same as V3		
V5		TUBE: 5ADP31 cathode ray	20875-256	72.93
V6		TUBE: 6BQ7A	20875-156	3.20
V7		Same as V6		
V8		TUBE: 1X2B	20875-122	1.70
V9		Same as V8		
V10		TUBE: 6G11	20875-260	3.17
V11		LAMP: NE-2 neon, 65 VAC, 90 VDC, 1/25 W	12270-26	.55
V12		Same as V11		
V13		Same as V1		

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
V14		Same as V1		
V15		TUBE: 6U8	20875-118	2.66
V16		TUBE: 6BV8	20875-199	3.97
V17		Same as V1		
V18		Same as V11		
V19		TUBE: GV3-A-1500	20875-258	10.20
V20		Same as V19		
XDS1		Not used		
XDS2		SOCKET ASSY: panel light, miniature screw base	19350-436	.52
XDS3		Same as XDS2		
XF1		HOLDER: for fuse, screw slot cap	8825-200	1.55
XV1		SOCKET: 9 pin, saddle top mtg. black bakelite, less center shield	19350-427	.58
XV2		Same as XV1		
XV3		Same as XV1		
XV4		Same as XV1		
XV5		not used		
XV6		Same as XV1		
XV7		Same as XV1		
XV8		Same as XV1		
XV9		Same as XV1		
XV10		SOCKET: 12 pin compactron, saddle mtg.	19350-365	.55
XV11		Not used		
XV12		Not used		
XV13		Same as XV1		
XV14		Same as XV1		
XV15		Same as XV1		
XV16		Same as XV1		
XV17		Same as XV1		
		BOOKLET: instructions	2490-497	3.00
		CASE ASSEMBLY	3145-655	36.13
		KNOB: molded, black, small, shaft hole size .253 to plastic	11505-87	.75

REF DESIG	NOTES	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
		KNOB: molded, black, large, shaft hole size .253 dia. drill thru	11505-90	.90
		KNOB: molded, black, large, shaft hole size .253 dia. to plastic	11505-91	.95
		KNOB: molded, red, large, shaft hole size .128 dia. to plastic	11505-94	.75
		LEAD ASSEMBLY	12450-396	.78
		LEAD ASSEMBLY: Test	12450-420	4.12

NOTE: A minimum billing charge of $3.50 will be assessed for any parts order. Prices are subject to change without notice

ELECTRO-LINE

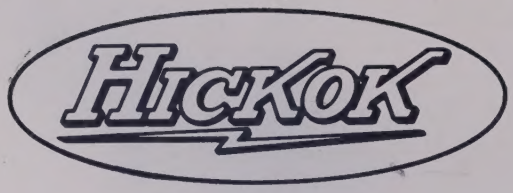


NOTES
UNLESS OTHERWISE NOTED, ALL RESISTANCE VALUES ARE IN OHMS, 10%, 1/2 WATT, K=1000, M=1,000,000.
ALL CAPACITANCE VALUES ARE IN MICROFARADS.
□ = DENOTES FRONT PANEL CONTROL.
◐ = DENOTES FRONT PANEL CONTROL (SCREWDRIVER ADJUST).
— + — = NO CONNECTION
—•— = CONNECTION
○ = DENOTES INTERNAL SCREWDRIVER ADJUST.

R & C SYMBOLS

LAST USED	NOT USED
R 177	
C 73	
L 4	
V 20	
Q 2	
CR 5	
S 3	
J 10	
J 11	
T1	DS3
P1	F1

SCHEMATIC WIRING DIAGRAM MODEL 770A


HICKOK